Spring 5-1-2020

The Effects of Elevated Pre-operative Hemoglobin A1c on Post-surgical Infection Risk

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THE EFFECTS OF ELEVATED PRE-OPERATIVE HEMOGLOBIN A1c ON POST-SURGICAL INFECTION RISK

by

An independent study submitted to

the faculty of the College of Nursing and the University

of North Dakota in partial fulfillment requirements for the degree of

MASTER OF SCIENCE IN NURSING

in

Family Nurse Practitioner

Emily Koska, RN, SFNP

Grand Forks, North Dakota

PERMISSION

Title The effects of elevated pre-operative hemoglobin A1c on post-surgical infection risk

Department Nursing

Degree Master of Science

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Abstract

The purpose of this literature review is to evaluate current evidence regarding elevated pre-operative hemoglobin A1c levels and its potential effect on post-operative infection risk. This case report discussion is a result of completion of an Objective Structured Clinical Examination (OSCE) for a patient who presented for a preoperative total knee arthroplasty (TKA) evaluation. Research for this literature review was conducted using CINAHL, Pubmed, and Google Scholar. Keywords used during this search included "elevated hemoglobin A1c and post-operative infection". Publication dates were limited between 2015 and 2020. A total of 10 research articles were collected and utilized for this review. The literature that was examined revealed conflicting evidence that chronic uncontrolled preoperative hyperglycemia, defined as a hemoglobin A1c greater than 8, is associated with poor post-surgical outcomes including increased risk for surgical site infection, postoperative wounds, and longer hospital stays.

Background

Type 2 diabetes mellitus is a disease caused by insulin resistance in which cells within the body no longer respond to insulin. Individuals at risk for type 2 diabetes include those that are overweight, over the age of 45, have a family history, poor physical activity, and those of African American, Hispanic, American Indian or Alaska Native background. Type 2 diabetes can be prevented by appropriate lifestyle changes leading to weight loss reduction through diet and exercise ("Type 2 Diabetes", 2019). According to the Centers for Disease Control (CDC), the incidence of type 2 diabetes mellitus is rapidly growing and affects more than 90-95% of over 34 million people in the United States that have been diagnosed with diabetes ("Type 2 Diabetes", 2019).

Individuals with diabetes mellitus are "more likely to require surgery than a person without and this is particularly notable for orthopedic surgery" (Akiboye & Rayman, 2017, p. 12). It is estimated that by 2030, in the United States there will be over 4 million joint arthroplasties performed with 8% of these patients having diabetes mellitus (Yang, Sun, Li, & Liu, 2017). Diabetes mellitus is a known risk factor for poor postoperative outcomes. Patients with diabetes have a 50% higher risk of postsurgical site infection compared to patients without diabetes (McCall, 2015). According to Han and Kang (2013), hyperglycemia causes impaired phagocytosis and delayed collagen synthesis, thus leading to poor wound healing and increased risk of infection. Additionally, anesthesia and surgery can lead to a stress response that releases various hormones throughout the body, such as cortisol and glucagon, causing increased insulin resistance and elevated glucose levels (Akiboye & Rayman, 2017).

The success of diabetic treatment can be monitored through hemoglobin A1c testing. Hemoglobin A1c is a blood test that is a marker for average blood glucose levels over the previous two to three months (Finger, et al., 2017). A diagnosis of type 2 diabetes can be made by a hemoglobin A1c greater than 6.5%. According to the American Diabetes Association (ADA), for individuals with diabetes the goal hemoglobin A1c is below 7% ("Understanding A1C", n.d.). For surgery, the ADA, Endocrine Society, and the American Association of Clinical Endocrinologists (AACE) recommend a peri-operative glucose less that 140mg/dL and a random blood glucose less than 180mg/dL (Akiboye & Rayman, 2017).

In this case report, the patient was seen for a preoperative evaluation and was scheduled for a right TKA. She had a diagnosis of controlled type 2 diabetes mellitus with a recent hemoglobin A1c level of 8.1 that had been trending upward in comparison to prior visits. She recently was non-compliant with her prescription for Victoza, a glucagon-like peptide-1 receptor

medication for her type 2 diabetes mellitus. During this visit, her elevated hemoglobin A1c was addressed and concerns for an increased risk of postsurgical infection was discussed. This literature review will explore evidence-based research concerning elevated pre-operative hemoglobin A1c and its potential effect on post-operative infection risk.

Case Report

Chief Complaint: Preoperative exam

HPI: Eileen is a pleasant 57-year-old female who presents to the office today for a preoperative consultation at the requirement of Dr. Piatt who plans on performing a right knee arthroplasty under general anesthesia on 3/4/20. This will be an outpatient procedure.

Past medical history:

Allergies: Amlodipine Besylate (Rash)**,** Cats (Watery eyes, difficult breathing)**,** Environmental allergens (Hayfever)

Medications:

1. Diclofenac sodium 75 mg delayed-release (enteric coated) tablet. Take 1 tablet (75 mg) by mouth 2 times a day 60 tablet.
2. Fluticasone 50 mcg/spray nasal spray. Spray 1 spray into each nostril 1 time per day 16 g.
3. Metformin 500 mg extended release tablet. Take 4 tablets by mouth per day.
4. Acetaminophen 400 mg tablet. Take 1,000 mg by mouth every 4 hours as needed.
5. Vitamin C 500 MG tablet. Take 1,000 mg by mouth 1 time per day.
6. Milk thistle-Tumeric capsule. Take 1 capsule by mouth 1 time per day.
7. Glipizide ER 10 mg extended release tablet (24 hr). Take 1 tablet (10 mg) by mouth 1 time per day.
8. Hydrochlorothiazide 25 mg tablet. Take 1 tablet (25 mg) by mouth 1 time per day.

9. Lovastatin 10 mg tablet. Take 1 tablet (10 mg) by mouth 1 time per day.
10. Benazepril 40 mg tablet. Take 1 tablet (40 mg) by mouth 1 time per day.
11. Multiple Vitamins-Minerals. Take 1 tablet by mouth 1 time per day.
12. Echinacea C Complete. Take 1 tablet by mouth 1 time per day.
13. Cinnamon. Take 1 capsule by mouth 1 time per day.

Medical:

1. Primary osteoarthritis of both knees
2. Controlled type 2 diabetes mellitus without complication, without long-term current use of insulin
3. CKD (chronic kidney disease), stage III
4. Hypercholesterolemia
5. Essential hypertension
6. Neuroma of foot
7. Obstructive sleep apnea of adult
8. Severe obesity
9. Hypomagnesemia

Surgical:

1. Left total knee arthroplasty

Family History: Her father had emphysema and her mother had diabetes. Her five siblings otherwise have a negative medical history.

Social History: She is married with two children and currently works at Explore MN tourism. She has never smoked or used tobacco. She currently has two alcoholic beverages per week. She has no history of drug use.

ROS

General: Denies fever, chills, night sweats, weight loss/gain or loss of appetite.

HEENT: Denies blurry vision, dysphagia, sore throat or congestion.

Neck: Denies stiffness or pain.

Respiratory: Denies wheezing, cough, and SOB.

Cardiovascular: Denies chest pain, tightness, palpitations, or edema.

Gastrointestinal: Denies nausea, vomiting, diarrhea, constipation, melena, hematochezia, or GERD.

Genitourinary: Denies incontinence, hematuria, dysuria, frequency, or urgency.

Musculoskeletal: Denies myalgias, arthralgias, or swollen joints.

Neurologic: Denies headaches, numbness, or weakness.

Lymph: Denies lymphadenopathy.

Hematology: Denies any bleeding or clotting disorders.

Psychiatric: Denies anxiety or depression.

Physical Examination

Vitals: BP: 136/90 P: 88

Weight: 168.3 kg (371 lb)

Body mass index is 53.23 kg/m².

General: The patient is a pleasant. No acute distress.

HEENT: Pupils equally round and reactive to light. Extraocular muscles are intact. Conjunctivae clear. Tympanic membranes normal with no erythema or bulging. No nasal edema or rhinitis. Good dentition with no loose teeth. Uvula midline. Pharynx with no erythema or exudate.

Neck: Trachea midline. Neck supple. No thyromegaly or thyroid nodules.

No supraclavicular or cervical lymphadenopathy.

Heart: Normal rate, regular rhythm, S1 normal, S2 normal and normal heart sounds.

Lungs: Clear to auscultation bilaterally with no wheezes or crackles. Effort normal and breath sounds normal.

Abdomen: Soft, nontender, nondistended. No hepatosplenomegaly. No rebound tenderness or guarding.

Musculoskeletal: Muscle strength is 5 out of 5 of the upper and lower extremities bilaterally.

Neurological: Cranial nerves II through XII are intact with gross examination. Deep tendon reflexes 2+ bilaterally to bicep, tricep, brachioradialis and patellar reflexes.

Skin: Skin is warm and dry. No abnormal lesions or rashes present.

Psychological: Normal concentration. No active depression or anxiety.

Labs/Diagnostics

1. Glucose 229, BUN 21, Creatinine 1.57, otherwise CMP unremarkable
2. CBC normal
3. Hemoglobin A1c 8.1
4. Magnesium normal
5. EKG normal sinus rhythm

Surgical risk

Surgical risk: Intermediate

History blood clotting or bleeding disorders: No

Has tolerated anesthesia in the past: Yes

Postoperative nausea: No

Pain, stiffness, arthritis of the neck: No

Preoperative risk assessment includes:

1. Cardiovascular status.

Patient has had no history of ischemia, MI, dysrhythmias, angina or cardiomyopathy. Does have history of HTN and HLD, which is controlled on medication. Her exam is unremarkable.

EKG: Unremarkable

ACC/AHA Cardiac Risk Factors:

History of ischemic heart disease: No

History of compensated or prior heart failure: No

History of cerebrovascular disease: No

Diabetes mellitus: Yes

Renal insufficiency >2: No

Functional Capacity:

Some shortness of breath when climbing two flights of stairs. No chest pain.

2. **Pulmonary status.**

Tobacco user: No

BMI: 53%

Patient does have a history of sleep apnea and is currently not wearing recommended CPAP at night. She has had a previous sleep study. Patient has history of asthma that is well controlled without medications. Patient has no history of COPD or other significant cardiorespiratory illness. No additional pulmonary assessment indicated.

3. General Risk/Nutrition

Gerd: No

Obesity: Yes

Anemia: Yes

Hearing impaired/hearing aids: Yes

Dentures: No

Dysphagia: No

3. Infectious risk.

Patient has no evidence of upper or lower respiratory infection, skin infection, or urinary tract infection. However, I do have concerns regarding healing and risk for infection post-surgery due to uncontrolled DM. MRSA screen: negative.

4. Cognitive status.

Patient has no history of excessive alcohol use, alcohol withdrawal symptoms, or drug use. She has no history of contraindications to use of post-operative pain medications or narcotic analgesics as needed.

Assessment

1. Primary osteoarthritis of both knees
2. Uncontrolled Type II diabetes
3. CKD (chronic kidney disease), stage III
4. Essential Hypertension
5. Hypercholesteremia
6. Obstructive Sleep Apnea
7. Severe Obesity, BMI 53%

Plan: I discussed with patient that I do not recommend proceeding with her surgery until she has better control of her blood sugars as poor blood sugar control is linked with decreased wound healing and increased risk of infection after surgery. I will consult with her surgeon regarding my

concerns. Keep taking oral diabetic medications. I recommend she start taking Rybelsus once daily to help improve glycemic control. Will re-check A1c in 3 months. I would also like her to see the diabetic educator. Her kidney function has steadily declined. Stop all NSAIDS to protect kidneys. Referral for nephrology. Blood pressures have been well controlled. Continue medications as prescribed. Continue medications as prescribed for hypercholesteremia. We discussed importance of wearing CPAP at night. We discussed diet modifications. Once blood sugars have improved, surgery should help increase exercise which will also help with weight management.

Literature Review

For diabetic patients undergoing TKA, poor preoperative glycemic control, including a hemoglobin A1c greater than 8%, has been linked with a higher risk of postoperative wound infections. A retrospective study conducted by Han and Kang (2013), explored 115 patients with type 2 diabetes mellitus who underwent a TKA and discovered that the risk of postoperative wound infection was correlated with a hemoglobin A1c greater than 8%. While the association may not be significant, overall 6.6% of the patients in their study had wound complications. They also found that not only was preoperative glycemic control important to decreasing the risk of wound infection, operative time was also a factor to be considered. This study suggested that surgeons should exercise caution when selecting patients, as well as consider operative time as a risk factor for poor outcomes.

Cancienne, Werner, & Browne (2017) additionally found that as perioperative hemoglobin A1c increases, so does the risk of postoperative deep infection requiring surgical intervention after TKA. In their cohort study, patients who had a hemoglobin A1c greater than 8% were more likely to develop an infection within one year after their TKA than those whose

hemoglobin A1c levels were less than 8%. While elevated hemoglobin A1c was associated with deep postoperative infection after TKA, they did conclude that hemoglobin A1c could not be used as an isolated predictor for post-operative infection due to poor sensitivity and intermediate specificity. Because of this finding, it is recommended that hemoglobin A1c be considered as a reference when assessing risk factors for infection prior to surgery along with other potential risk factors (Cancienne, Werner, & Browne, 2017).

While multiple studies have been outlined that support an elevated hemoglobin A1c greater than 8% in diabetic patients undergoing a TKA with an increased risk of post-surgical infection, a meta-analysis conducted by Yang, Sun, Li, & Liu (2017) did not find a specific optimal threshold for hemoglobin A1c and increased post-surgical joint infection risk. However, their meta-analysis of 6 retrospective studies did demonstrate that there was a significantly higher risk of periprosthetic joint infections in association to hemoglobin A1c levels, thus warranting the screening of hemoglobin A1c to assess deep infection risk prior to surgery.

Multiple studies outside of TKA procedures have also suggested increased post-operative infectious risk in diabetic patients. A prospective, observational pilot study by Chen et al. (2018) followed noncardiac surgical patients for one week after their procedure. During the first 7 days after surgery, 9 patients with a A1c greater than 7% developed infections including urinary tract infections, surgical wound infections, or hospital-acquired pneumonia (Chen, et al., 2018). Additionally, they found that patients with a hemoglobin A1c greater than 7% had significantly higher variability with their postoperative glucose levels, making postoperative glycemic control difficult. Preoperative hemoglobin A1c levels greater than 7% have also been linked with higher rates of surgical site infections for individuals undergoing lumbar spinal instrumentation and thoracic surgery. Additionally, hemoglobin A1c levels higher than 7% also carry an increased

risk of mortality in patients undergoing primary joint arthroplasty (Akiboye & Rayman, 2017). Finger et al. (2017) discovered a correlation of increased postoperative infection risk, including sepsis, urinary tract infections, and pneumonia, along with increased hospital stay among patients undergoing cardiac surgical procedures with a hemoglobin A1c greater than 7%. Considering these findings, it is suggested that glycemic control should be optimized before scheduling elective surgeries for patients (Chen, et al., 2018).

One interesting aspect to consider is how hemoglobin A1c screening prior to surgery allows for closer monitoring during the perioperative and postoperative period. Jones et al. (2014) discuss how elevated hemoglobin A1c before gastrointestinal surgery can help to identify patients that are at a higher risk of post-operative hyperglycemia. Post-operative hyperglycemia can lead to complications such as increased post-operative infections, increased length of stay, and increased mortality among patients. In their observational cohort study, post-operative hyperglycemia was linked with hospital readmission, but elevated pre-operative hemoglobin A1c was not. They suggest this is the result of the ability of providers to identify these increased risk factors through hemoglobin A1c screening prior to gastrointestinal surgery. This led to closer glucose monitoring and insulin use post-operatively which decreased infection rates and improved outcomes. Glycemic control post-operative was identified as keeping the patient's glucose levels under 250mg/dL as patients with glucose levels greater than 250mg/dL were 20% more likely to be readmitted (Jones, et al., 2014).

Lack of post-operative glycemic control has also been found to increase infectious complications in a retrospective study completed by Reátegui et al. (2014). While preoperative hemoglobin A1c has been the focus of this case report, it is important to outline the significance of post-operative glycemic control and its effect on infectious risk. Both diabetic and non-

diabetic patients undergoing TKA were examined in their retrospective study and a high rate of post-operative complications were found in patients one year after their TKA. Those post-operative complications included urinary tract infections, wound infection, prosthetic infection, phlebitis, and sepsis. Infections were discovered in 11.3% of the 833 patients studied (Reátegui, et al., 2014). Despite what other studies have found, in their study they did not find a correlation between diabetes mellitus and complications. Rather they discovered that stress-induced hyperglycemia as a result of the surgical process led to increased infections regardless of a diabetes mellitus diagnosis. Overall, their study concluded that proper post-operative glycemic control for all patients, despite a diagnosis of diabetes mellitus, is imperative to reducing post-operative infections. Contrary to their findings, Finger et al. (2017) determined that while hyperglycemia perioperatively was associated with postoperative infections, chronic elevated hemoglobin A1c was also a risk factor for postsurgical infections, even with tight perioperative glycemic control.

A retrospective study performed by Underwood et al. (2014) revealed that of all of the diabetic patients enrolled, 65% of them did not have a recent A1c measurement within the previous 3 months available. This is an area of concern for diabetic patients going into surgery because of the known increase risk of poor outcomes and suggests that inadequate glycemic control may be occurring during the perioperative period. Due to lack of data, anesthesiologists, surgeons, endocrinologists, and internists are using subjective A1c guidelines with some surgeons using the ADA recommendation of a hemoglobin A1c less than 7% before performing elective surgeries (Underwood, et al., 2014). Underwood et al. (2014) suggest that algorithms should be utilized by surgeons and anesthesiologists to help improve glycemic control for patients with a hemoglobin A1c greater than 8% so that those individuals that are considered

high risk are more easily identified and appropriately treated throughout the preoperative and perioperative period.

Additional risk factors have been identified as an important component for the surgeon to consider prior to surgery. Blankush et al., (2016) propose age, wound classification, and surgical risk classification as strong indicators of post-surgical infection risk in addition to hemoglobin A1c. In their retrospective study, they revealed that elevated pre-operative A1c greater than 7% was not an adequate solo indicator of infectious risk post-surgery. However, they did discover that hemoglobin A1c did have predictive value for post-operative infection risk when applied to certain subgroups within their study. Patients with a preoperative hemoglobin A1c greater than 8% and a dirty wound had a higher risk for post-operative infection. Also, patients older than 81 years of age, regardless of wound classification, with a pre-operative hemoglobin A1c greater than 7.5% were more likely to suffer a post-operative infection with rates being as high as 1 in 4 (Blankush, et al., 2016). This study was interesting as it suggested post-operative infection risks as complex, with subgroups being affected differently based on the combination of both elevated pre-operative hemoglobin A1c levels and other risk factors. Akiboye & Rayman (2017) further recommend considering co-morbid conditions, especially for orthopedic surgeries, when assessing post-surgical infection risk. Co-morbid conditions include hypertension, obesity, sleep apnea, and vascular changes associated with diabetes mellitus. By identifying these risk factors, surgeons can more readily assess which subgroups may be at higher risk of post-operative infection and may optimize medications and hyperglycemia prior to surgery to improve outcomes.

Learning Points

- For diabetic patients undergoing TKA, poor preoperative glycemic control, including a hemoglobin A1c greater than 8%, is linked with a higher risk of postoperative wound infections.
- Checking a hemoglobin A1c prior to surgery can allow for closer monitoring of hyperglycemia in diabetic patients during the preoperative and perioperative period, improving postsurgical outcomes.
- The pre-operative assessment should include a risk assessment of the diabetic patient, taking into account their secondary complications due to diabetes and co-morbidities as this has been correlated with an increased risk of postoperative complications including infection. Medications and glycemia should also be optimized prior to surgery.

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